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Comparison of biochemical response between the minimally invasive and standard open posterior lumbar interbody fusion

Petr Linzer [a,*], Michal Filip [a], Patrik Jurek [a], Tomáš Šálek [b], Miroslav Gajdoš [c], Jiří Jarkovský [d]

[a] Department of Neurosurgery, Bata Hospital, Zlín, Czech Republic
[b] Department of Biochemistry, Bata Hospital, Zlín, Czech Republic
[c] Department of Neurosurgery, Pavol Josef Šafárik University, Košice, Slovakia
[d] Institute of Biostatistics and Analyses, Masaryk University, Brno, Czech Republic

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ABSTRACT

Background: The mini-invasive open posterior lumbar fusion procedure (mini PLIF) procedure is an alternative to standard open procedure (open PLIF) and is intended to reduce surgery-related trauma. The measuring of suitable biochemical factors enables objective comparison of the invasiveness of spinal surgery procedures.

Methods: Prospectively collected data on myoglobin, creatine kinase, interleukin-6, C-reactive protein levels and intensity of low back pain and radicular pain in one-level mini PLIF and open PLIF procedures were analysed. The mini PLIF and the open PLIF groups included 27 and 23 patients, respectively. The collection of blood samples and clinical data were performed preoperatively and on postoperative days 1, 3 and 7. The non-paired *t*-test was used for statistical evaluation.

Results: We did not found any statistically significant differences of myoglobin and creatine kinase levels between the groups. In the open PLIF group the IL-6 levels were significantly higher than in the mini PLIF group on postoperative day 3. CRP levels showed significant lower stress response in favour of the mini PLIF group on postoperative days 3 and 7. Levels of post-op low back pain on day 3 were significantly lower in mini PLIF group. Also intensity of radicular pain on day 1 and 3 were lower also mini PLIF group.

Conclusion: The extent of myonecrosis was comparable in both techniques. The analysis of the IL-6 and CRP levels showed significantly lower systemic inflammatory response in mini PLIF technique. The mini PLIF technique provides transiently lower postoperative pain levels.

* *Corresponding author at*: Department of Neurosurgery, Bata Hospital, Havlíčkovonábřeží 600, 762 75 Zlín, Czech Republic. Tel.: +420 603927931; fax: +420 577552107.
E-mail address: petrlinzer@volny.cz (P. Linzer).

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1. Introduction

The standard posterior surgical approach for posterior interbody fusion (PLIF) is a widely used surgical technique for treatment of a degenerative disease of the lumbar spine. Nowadays various minimally invasive modifications of open fusion procedures have become more and more popular among spinal surgeons. The aim of mini-invasive surgical techniques is the reduction of undesirable collateral soft tissue damage related to an open approach. Published data comparing open and mini-invasive operational techniques show comparable clinical as well as radiological results [1–4]. Frequently mentioned advantages of mini-invasive techniques are lower blood loss, faster recovery, shorter length of stay and also lower frequency of inflammatory complications [3,5–8]. However, mini-invasive operational techniques are technically demanding, expensive and take longer time. Mastering of the technique also requires a long learning curve. To confirm or refuse the hypothesis that mini-invasive technique is justified and advantageous, objective methods may be employed. An objective comparison of the invasiveness of surgical procedures proposes the biochemically oriented approach. A postoperative monitoring of suitable biochemical markers enables an assessment of the inflammatory response and the extent of muscle damage.

Any surgical intervention induces stress and an inflammatory response in the body, which is proportional to the access size, blood loss and length of exposure [9,10]. Proinflammatory interleukin-6 (IL-6) is produced at the site of the insult and subsequently enters the peripheral blood. Liver synthesis of C-reactive protein (CRP) is induced in response to the release of interleukin-1 (IL-1) and IL-6. Many authors comparing invasiveness of the surgical procedures studied the levels of the mentioned biochemical factors [11–16]. Analogously to their use in the diagnosis of myocardial ischaemia, elevated levels of specific muscle proteins reflect the size of the lesion of the skeletal muscles. An insult leads to an increase in serum concentrations of a number of proteins, such as creatine kinase (CK), myoglobin (MYO), lactate dehydrogenase, aminotransferases and others [14,15,17–22].

The objective of this study is to compare the invasiveness between the minimally invasive PLIF (mini PLIF) and the standard open PLIF (open PLIF) based on total stress response (IL-6, CRP) and muscle trauma (CK and MYO).

2. Material and methods

We analysed prospectively collected data from patients operated on using the one-level mini PLIF technique and the open PLIF. 27 consecutive patients were included in the mini PLIF group and 23 patients underwent the open PLIF procedure in the same period. Inclusion criteria were: lumbar degenerative disc disease, radiological and/or clinical signs of segmental instability, clinical signs of spinal nerve compression and 6 months of unsuccessful conservative treatment. Exclusion criteria were previous lumbar spine procedures, corticosteroid medication, abnormal baseline preoperative values of the observed parameters and patients with infectious, hepatic, cardiac and autoimmune diseases. Patients with suspected postoperative inflammatory complications and intramuscular medication delivery were also excluded. The choice of surgical technique was left to the individual preferences of the participating neurosurgeons. Procedures were performed under general anaesthesia and perioperative administration of anaesthetics included sevoflurane, intravenous application of propofol 2.5 mg/kg, sufentanil 0.2–0.4 μg/kg and cisatracurium 0.15 mg/kg.

The mini PLIF surgical technique included unilateral decompression and posterior interbody fusion supplemented by percutaneous pedicular fixation as described by Logroscino et al. [23]. The procedure was performed in a prone position with an appropriate padding of a patient to avoid abdomen compression. After X-ray localisation a short paramedial incision on the side of prevailing symptoms, the dilatation and insertion of a 21 mm wide tubular retractor were performed. Decompression, discectomy and preparation of interbody space were performed under control of microscope. One cage filled with autologous bone was inserted into interbody space (Capstone – Medtronic Sofamor Danek USA, Inc.; Concorde – DePuy Synthes, USA). Bone material was harvested from laminae during an approach into the spinal canal. After cage insertion and wound closure, percutaneous bilateral insertion of a pedicle screw fixation followed (CD Horizon Sextant II – Medtronic Sofamor Danek USA, Inc., VIPER 2 – DePuy Synthes, USA).

In the open PLIF group the surgical technique included a midline incision, soft tissue dissection, paravertebral muscle dissection and retraction up to bases of transverse processes. After a standard laminectomy and bilateral discectomy one or two interbody cages were inserted. The insertion of a pedicle screw fixation followed (XIA – Stryker, USA).

Samples for biochemical analysis were collected using the standard venipuncture technique on the day before surgery, and on postoperative days 1, 3 and 7. Samples were sent to the laboratory and measured in an automatic analyser. CRP levels were measured using a high-sensitive latex immunoturbidimetric assay on the Abbott Architect analyser. IL-6 levels were determined using a sandwich immunoassay with electrochemiluminescence detection on the Cobas e-411 analyser. CK activity was measured using the enzymatic photometric method on the Abbott Architect analyser, while myoglobin levels were determined by a particle enhanced immunoturbidimetric assay on the same analyser. The normal reference laboratory values were as follows: CRP ≤ 5 mg/L, IL-6 ≤ 7 ng/L, CK ≤ 3.25 μkat/L and myoglobin ≤ 117 μg/L. Reference ranges were established according to manufacturer and the laboratory procedures performed according to International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) recommendation.

Preoperative and post-op values on the 10-grade visual analogue pain scale for low back pain (VAS BP) and radicular pain (VAS R) were also recorded.

Any intramuscular administration of the medications was excluded during the preoperative and postoperative periods. Patients were allowed to ambulate on the third day after the surgery. The time of operation was obtained from the clinical records. Postoperative analgesia included patient-controlled administration of paracetamol, metamizol, and tramadol.